Renewable and Sustainable Energy Reviews 14 (2010) 3220–3225

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

CO_2 emissions, energy consumption and economic growth in Turkey

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ARTICLE INFO

Article history:
Received 18 May 2010
Accepted 7 July 2010

JEL classification:
Q43
Q53
Q56

Keywords:
Carbon dioxide emission
Energy consumption
Economic growth
Granger causality
Turkey

ABSTRACT

This paper examines the long run and causal relationship issues between economic growth, carbon emissions, energy consumption and employment ratio in Turkey by using autoregressive distributed lag bounds testing approach of cointegration. Empirical results for Turkey over the period 1968–2005 suggest an evidence of a long-run relationship between the variables at 5% significance level in Turkey. The estimated income elasticity of carbon emissions per capita is −0.606 and the income elasticity of energy consumption per capita is 1.375. Results for the existence and direction of Granger causality show that neither carbon emissions per capita nor energy consumption per capita cause real GDP per capita, but employment ratio causes real GDP per capita in the short run. In addition, EKC hypothesis at causal framework by using a linear logarithmic model is not valid in Turkish case. The overall results indicates that energy conservation policies, such as rationing energy consumption and controlling carbon dioxide emissions, are likely to have no adverse effect on the real output growth of Turkey.

Contents

1. Introduction

Global warming and climate change have been one of the most important environmental problems in the last two decades. The ever increasing amount of carbon dioxide (CO_2) emissions (hereafter carbon emissions), the dominant contributor to the greenhouse effect, seems to be aggravating this problem (see Kaygusuz [1]). Among the greenhouse gases, carbon dioxide is responsible for more than 60% of the greenhouse effect. Thus, the impacts of global warming and climate change on the world economy have been assessed intensively by academics and practitioners. In addition, worldwide organizations, such as the United Nations, have been attempting to reduce the adverse impacts of global warming and climate changes through intergovernmental and binding agreements, such as the Kyoto Protocol (see Halicioglu [2]). The Kyoto Protocol is a protocol to the United Nations Framework Convention on Climate Change (UNFCCC), aimed at combating global warming. The UNFCCC is an international environmental treaty with the goal of achieving "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system". The Protocol was initially adopted on 11

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1364-0321/$ – see front matter
doi:10.1016/j.rser.2010.07.005

Table 1
Summary of causality test results with related earlier studies for Turkey.

Authors	Period	Variables	Methodology	Conclusion
Soytas et al. [18]	1960–1995	Energy consumption; GDP	Granger causality; VEC; JJ cointegration	$EC \rightarrow GDP$
Soytas and Sari [11]	1950–1992	Energy consumption; GDP	Granger causality; VEC; JJ cointegration	$EC \rightarrow GDP$
Altinay and Karagol [19]	1950–2000	Energy consumption; GDP	Hsiao causality; Zivot–Andrews structural break test	$EC \neq GDP$
Say and Yucel [20]	1970–2002	GNP, total energy consumption, Carbon emissions, population	OLS	EC has positive effect on GDP CO_2 emissions have positive effect on EC
Lise [12]	1980–2003	GNP, Carbon emissions	OLS	CO_2 emissions have positive effect on GDP
Lise and Monfort [21]	1970–2003	Energy consumption; GDP	Granger causality; VEC; JJ cointegration	$GDP \rightarrow EC$
Jobert and Karanfil [22]	1960–2003	Energy consumption; GDP	Granger causality; VAR.	$EC \neq GDP$
Erdal et al. [23]	1970–2006	Energy consumption; GDP	Granger causality; VEC; JJ cointegration	$EC \leftrightarrow GDP$
Halicioglu [2]	1960–2005	Carbon emissions; Energy consumption; GDP; Foreign Trade	Granger causality ARDL cointegration	$EC \leftrightarrow CO_2$ $CO_2 \leftrightarrow GDP$ $FT \neq CO_2$ $EC \neq GDP$
Soytas and Sari [13]	1960–2000	Energy consumption; carbon emissions; Labor; gross fixed capital investment; GDP	TY causality	$CO_2 \neq GDP$ $CO_2 \rightarrow EC$ $EM \rightarrow EC$

Notes: $\rightarrow$, $\leftrightarrow$ and $\neq$ represent unidirectional causality, bidirectional causality, and no causality, respectively. Abbreviations are defined as follows: VAR: vector autoregressive model, VEC: vector error correction model, JJ: Johansen–Juselius, TY: Toda–Yamamoto, OLS: ordinary least squares, ARDL: autoregressive distributed lag, GDP: real gross domestic product, EC: energy consumption, CO_2: carbon dioxide, FT: foreign trade, EM: employment ratio.

December 1997 in Kyoto, Japan and entered into force on 16 February 2005. As of November 2009, 187 states have signed and ratified the protocol. Although Turkey signed Kyoto Protocol in 2009, it will not be obligated to reduce its emissions until 2012.

There seems to be basically three research strands in literature on the relationship between economic growth, energy consumption and environmental pollutants [3]. The first strand focuses on the environmental pollutants and economic growth nexus. It is closely related to testing the validity of the so-called environmental Kuznets curve (EKC) hypothesis, which postulates an inverted U-shaped relationship between the level of environmental degradation and income growth. That is to say, environmental degradation increases with per capita income during the early stages of economic growth, and then declines with per capita income after arriving at a threshold. The EKC hypothesis was first proposed and tested by Grossman and Krueger [4]. The studies of Stern [5] and Dinda [6], among others, provide extensive review surveys of the studies which tested the economic growth and environmental pollution nexus.

The second strand of the research is related to energy consumption and output nexus. This nexus suggests that economic development and output may be jointly determined, because economic growth is closely related to energy consumption as higher economic development requires more energy consumption [2]. Following the study of Kraft and Kraft [7], an extensive number of empirical works have assessed the empirical evidence employing Granger causality and cointegration model. The earlier studies mostly apply a bivariate model and fail to get consensus results. However, the multivariate studies also produce conflicting results. Ozturk [8] provides an extensive review survey of the studies on the empirical results from causality tests between energy consumption and economic growth.

The third strand is a combined approach of these two methods which is implied to investigate validity of both nexuses in the same framework. This approach investigates the dynamic relationships between economic growth, environmental pollutants and energy consumption alltogether (see Ang [9], Soytas et al. [10], Soytas and Sari [11], Zhang and Cheng [3]).

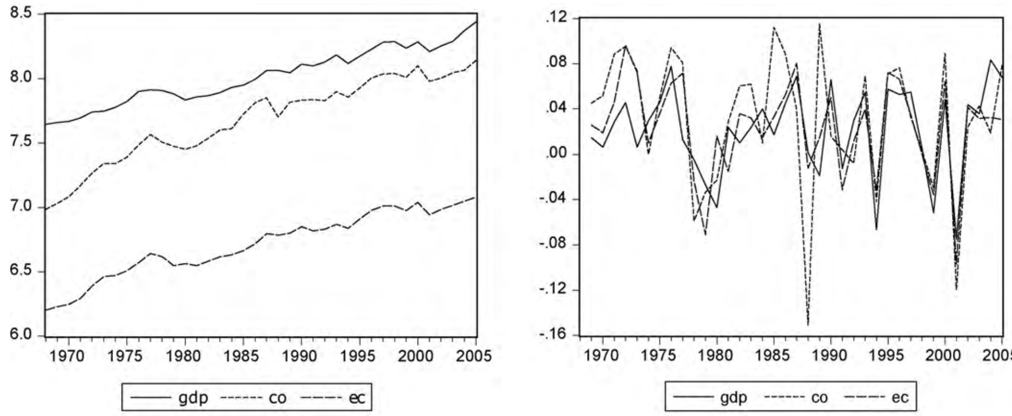
The causality and ordinary least squares (OLS) regression results of previous studies for Turkey are summarized in Table 1. The empirical studies using the same country data also failed to achieve unanimous conclusions. There are limited empirical studies about the testing of the EKC hypothesis for Turkish economy: Lise [12] rejects EKC hypothesis and finds a linear EKC path; Soytas and Sari [13] find a no long-run causal relationship between carbon emissions, energy consumption and GDP; Akbostanci et al. [14] find that Turkish data do not confirm EKC hypothesis by using time series and panel data models; and Halicioglu [2] finds a long run and causal relationships between carbon emissions, energy consumption and GDP by using a linear logarithmic quadratic model.

The choice of Turkey is motivated by the fact that Turkey has experienced a significant rise in energy consumption and carbon emissions in recent decades; it is an emerging economy, a candidate country for full membership to the European Union (EU) and one of the important countries which has a high carbon emission in the world. In addition, Turkey will likely to face significant pressures from EU during negotiations to introduce its national plan on climate change and global warming along with specific emission targets and the associated abatement policies. According to World Development Indicators of The World Bank [15], Turkey's share of carbon emissions in the world was 23rd place and the share of Turkey in the total world carbon emissions was 1% in 2006. In addition, real GDP per capita, carbon emissions per capita (metric kg) and energy use per capita (kg of oil equivalent) are move and increase on the same way in the growing Turkish economy (see Fig. 1). Thus, it will be suitable to investigate the relationship and causality issues between these variables.

In this paper, we examine the long run and causal relationships issues between economic growth, carbon emissions, energy consumption and employment ratio in Turkey by using recently developed autoregressive distributed lag (hereafter ARDL) bounds testing approach of cointegration by Pesaran and Shin [16] and Pesaran et al. [17], and error-correction based Granger causality models for Turkey over 1968–2005 period. The rest of the paper is organized as follows. The next section presents the methodology and data. The third section reports the empirical results. The last section concludes the paper.

2. Methodology and data

Most of the earlier empirical causality studies on energy – growth and environmental pollutants – economic growth nexuses



(a) in log levels (b) in growth rates

Fig. 1. Real GDP per capita, carbon emissions per capita (metric kg), energy use per capita (kg of oil equivalent).

were using only two variables. In other words, they were employed bivariate models which cause an omitted variable problem. Thus, to avoid this problem, we employed a multivariate model in this study. To investigate the long-run relationship between carbon emissions per capita, energy consumption per capita, employment ratio (in percent) and real GDP per capita, we employed the following equation:

$$gdp_t = \alpha + \beta co_t + \theta ec_t + \varphi em_t + \varepsilon_t \tag{1}$$

where $gdp_t = \ln(\mathrm{GDP}_t/N_t)$, $co_t = \ln(\mathrm{CO}_{2_t}/N_t)$, $ec_t = \ln(\mathrm{EC}_t/N_t)$, $em_t = \ln(100 \times \mathrm{EM}_t/N_t)$ and ε_t is the error term; GDP is real GDP (constant 2000 US$), N is total population, CO_2 is carbon dioxide emissions (metric kg), EC is energy use (kg of oil equivalent) and EM is total labor force. The annual Turkish time series (except labor force) data are taken for 1968–2005 from the World Development Indicators (WDI) online database and data for total labor force is obtained from Turkish Statistical Institute [24]. All variables are employed with their natural logarithms form to reduce heteroscedasticity and to obtain the growth rate of the relevant variables by their differenced logarithms.

The long run and causal relationships between economic growth, carbon emissions, energy consumption and employment ratio in Turkey will be performed in two steps. Firstly, we will test the long-run relationships among the variables by using the ARDL bounds testing approach of cointegration. Secondly, we test causal relationships by using the error-correction based causality models.

2.1. Autoregressive distributed lag (ARDL) cointegration analysis

The ARDL bounds testing approach of cointegration is developed by Pesaran and Shin [16] and Pesaran et al. [17]. The ARDL cointegration approach has numerous advantages in comparison with other cointegration methods such as Engle and Granger [25], Johansen [26], and Johansen and Juselius [27] procedures: (i) no need for all the variables in the system be of equal order of integration, (ii) it is efficent estimator even if samples are small and some of the regressors are endogenous, (iii) it allows that the variables may have different optimal lags, and (iv) it employs a single reduced form equation.

Basically, this approach involves two steps for estimating long-run relationship. The first step is to investigate the existence of long-run relationship among all variables in the equation. The ARDL model for the standard log-linear functional specification of long-run relationship between carbon emissions per capita, energy consumption per capita, employment ratio and real GDP per capita may follows as:

$$\Delta gdp_t = \alpha_1 + \sum_{i=1}^{a1}\phi_{1i}\Delta gdp_{t-i} + \sum_{j=0}^{b1}\beta_{1j}\Delta co_{t-j} + \sum_{p=0}^{c1}\theta_{1p}\Delta ec_{t-p} + \sum_{q=0}^{d1}\varphi_{1q}\Delta em_{t-q} + \delta_1 gdp_{t-1} + \delta_2 co_{t-1} + \delta_3 ec_{t-1} + \delta_4 em_{t-1} + \varepsilon_{1t} \tag{2}$$

where ε_{1t} and Δ are the white noise term and the first difference operator, respectively. An appropriate lag selection based on a criterion such as Akaike Information Criterion (AIC) and Schwarz Bayesian Criterion (SBC). The bounds testing procedure is based on the joint F-statistic or Wald statistic that is tested the null of no cointegration, $H_0: \delta_r = 0$, against the alternative of $H_1: \delta_r \neq 0$, $r = 1, 2, 3, 4$.

Two sets of critical values that are reported in Pesaran et al. [17] provide critical value bounds for all classifications of the regressors into purely $I(1)$, purely $I(0)$ or mutually cointegrated. If the calculated F-statistics lies above the upper level of the band, the null is rejected, indicating cointegration. If the calculated F-statistics is below the upper critical value, we cannot reject the null hypothesis of no cointegration. Finally, if it lies between the bounds, a conclusive inference cannot be made without knowing the order of integration of the underlying regressors. Recently, Narayan [28] argues that exiting critical values, because they are based on large sample sizes, cannot be used for small sample sizes. Narayan [28] regenerated the set of critical values for the limited data ranging from 30 to 80 observations by using the Pesaran et al.'s [17] GAUSS code. With the limited annual time series Turkish data on carbon emissions per capita, energy consumption per capita, employment ratio and real GDP per capita, this study employs the critical values of Narayan [28] for the bounds F-test rather than Pesaran et al. [17].

The second step is to estimate the following long-run and short-run models that are represented in Eqs. (3) and (4) if there is evidence of long-run relationships (cointegration) between these variables.

$$gdp_t = \alpha_2 + \sum_{i=1}^{a1}\phi_{2i} gdp_{t-i} + \sum_{j=0}^{b1}\beta_{2j} co_{t-j} + \sum_{p=0}^{c1}\theta_{2p} ec_{t-p} + \sum_{q=0}^{d1}\varphi_{2q} em_{t-q} + \varepsilon_{2t} \tag{3}$$

Table 2
The null hypotheses for Granger causalities.

	Short-run				Long-run
	Δgdp	Δco	Δec	Δem	ψ_i
Δgdp	–	$\pi_{12,1}=\ldots=\pi_{12,k}=0$	$\pi_{13,1}=\ldots=\pi_{13,k}=0$	$\pi_{14,1}=\ldots=\pi_{14,k}=0$	$\psi_1=0$
Δco	$\pi_{21,1}=\ldots=\pi_{21,k}=0$	–	$\pi_{23,1}=\ldots=\pi_{23,k}=0$	$\pi_{24,1}=\ldots=\pi_{24,k}=0$	$\psi_2=0$
Δec	$\pi_{31,1}=\ldots=\pi_{31,k}=0$	$\pi_{32,1}=\ldots=\pi_{32,k}=0$	–	$\pi_{34,1}=\ldots=\pi_{34,k}=0$	$\psi_3=0$
Δem	$\pi_{41,1}=\ldots=\pi_{41,k}=0$	$\pi_{42,1}=\ldots=\pi_{42,k}=0$	$\pi_{43,1}=\ldots=\pi_{43,k}=0$	–	$\psi_4=0$

$$\Delta gdp_t = \alpha_3 + \sum_{i=1}^{a1}\phi_{3i}\Delta gdp_{t-i} + \sum_{j=0}^{b1}\beta_{3j}\Delta co_{t-j} + \sum_{p=0}^{c1}\theta_{3p}\Delta ec_{t-p} + \sum_{q=0}^{d1}\varphi_{3q}\Delta em_{t-q} + \psi ECT_{t-1} + \varepsilon_{3t} \quad (4)$$

where ψ is the coefficient of error correction term (hereafter *ECT*). ECT, defined as:

$$ECT_t = gdp_t - \alpha_2 - \sum_{i=1}^{a1}\phi_{2i}gdp_{t-i} - \sum_{j=0}^{b1}\beta_{2j}co_{t-j} - \sum_{p=0}^{c1}\theta_{2p}ec_{t-p} - \sum_{q=0}^{d1}\varphi_{2q}em_{t-q} \quad (5)$$

It shows how quickly variables converge to equilibrium and it should have a statistically significant coefficient with a negative sign.

2.2. Causality analysis

ARDL cointegration method tests the existence or absence of long-run relationships between carbon emissions per capita, energy consumption per capita, employment ratio and real GDP per capita. It does not indicate the direction of causality. We use the two-steps procedure from the Engle and Granger [25] model to examine the causal relationship between carbon emissions per capita, energy consumption per capita, employment ratio and real GDP per capita. Once estimating the long-run model in Eq. (3) in order to obtain the estimated residuals, the next step is to estimate error-correction based Granger causality models. As opposed to the conventional Granger causality method, the error-correction based causality test allows for the inclusion of the lagged error-correction term derived from the cointegration equation (see Odhiambo [29]). Thus, the following models may employ to explore the causal relationships between the variables:

$$\begin{bmatrix}\Delta gdp_t\\ \Delta co_t\\ \Delta ec_t\\ \Delta em_t\end{bmatrix} = \begin{bmatrix}\mu_1\\ \mu_2\\ \mu_3\\ \mu_4\end{bmatrix} + \begin{bmatrix}\pi_{11,1} & \pi_{12,1} & \pi_{13,1} & \pi_{14,1}\\ \pi_{21,1} & \pi_{22,1} & \pi_{23,1} & \pi_{24,1}\\ \pi_{31,1} & \pi_{32,1} & \pi_{33,1} & \pi_{34,1}\\ \pi_{41,1} & \pi_{42,1} & \pi_{43,1} & \pi_{44,1}\end{bmatrix}\begin{bmatrix}\Delta gdp_{t-1}\\ \Delta co_{t-1}\\ \Delta ec_{t-1}\\ \Delta em_{t-1}\end{bmatrix} + \cdots + \begin{bmatrix}\pi_{11,k} & \pi_{12,k} & \pi_{13,k} & \pi_{14,k}\\ \pi_{21,k} & \pi_{22,k} & \pi_{23,k} & \pi_{24,k}\\ \pi_{31,k} & \pi_{32,k} & \pi_{33,k} & \pi_{34,k}\\ \pi_{41,k} & \pi_{42,k} & \pi_{43,k} & \pi_{44,k}\end{bmatrix}\begin{bmatrix}\Delta gdp_{t-k}\\ \Delta co_{t-k}\\ \Delta ec_{t-k}\\ \Delta em_{t-k}\end{bmatrix} + \begin{bmatrix}\psi_1\\ \psi_2\\ \psi_3\\ \psi_4\end{bmatrix} ECT_{t-1} + \begin{bmatrix}\varepsilon_{4t}\\ \varepsilon_{5t}\\ \varepsilon_{6t}\\ \varepsilon_{7t}\end{bmatrix} \quad (6)$$

Residual terms, $\varepsilon_{4t}, \varepsilon_{5t}, \varepsilon_{6t}$ and ε_{7t}, are independently and normally distributed with zero mean and constant variance. An appropriate lag selection is based on a criterion such as AIC and SBC. Using Eq. (6), causal relationships can be examined in two ways:

(i) Short-run or weak Granger causalities are detected through the *F*-statistics or Wald test for the significance of the relavant π coefficients on the first differenced series.
(ii) Another possible source of causation is the *ECT* in equations; the long-run causalities are examined through the t-test or Wald test for the significance of the relavant ψ coefficients on the lagged error–correction term (see Table 2).

Table 3
Estimated coefficients.

Variables			Short-run		Long-run
gdp (−1)			0.571 [0.000]		
co			0.059 [0.597]		−0.606 [0.061]
co (−1)			−0.161 [0.088]		
co (−2)			0.157 [0.032]		
ec			0.590 [0.001]		1.375 [0.001]
em			−0.430 [0.040]		−1.101 [0.011]
em (−1)			0.509 [0.056]		
em (−2)			−0.554 [0.015]		
Constant			3.163 [0.004]		7.376 [0.002]
R^2	0.991	NORM	0.481 [0.786]	*ECT*	−0.429 [0.001]
Adj. R^2	0.988	LM	0.921 [0.337]	*F*	4.657
SEE	0.022	HET	0.001 [0.988]		

Notes: SEE is the standard error of the regression. NORM is a test for normality of residuals with a χ^2 distribution with two degrees of freedom. LM is the Lagrange multiplier test for serial correlation with a χ^2 distribution with four degrees of freedom. HET is test for heteroskedasticity with a χ^2 distribution with only one degree of freedom. ECT is the estimated coefficient of error correction term. *p*-Values for the estimated coefficients and statistics are in [ ]. *F* is the ARDL cointegration test. The critical values for the lower *I*(0) and upper *I*(1) bounds are 3.164 and 4.194 for 5% significance levels, respectively (Narayan [28], Appendix: Case II).

3. Empirical results

According to Pesaran and Shin [16], the SBC is generally used in preference to other criteria because it tends to define more parsimonious specifications. With the limited observations, this study used the SBC to select an appropriate lag for the ARDL model. Table 3 presents the estimated ARDL (1,2,2,0) model that has passed several diagnostic tests that indicate no evidence of serial correlation and heteroscedasticity.

The bounds *F*-test for cointegration test yields evidence of a long-run relationship between carbon emissions per capita, energy consumption per capita, employment ratio and real GDP per capita at 5% significance level in Turkey. While the estimated log-linear long-run coefficient of carbon emissions per capita is −0.606 and the estimated log-linear long-run coefficient of energy consumption per capita is 1.375. The first coefficient implies the income elasticity of carbon emissions per capita and an increase in carbon emissions per capita will decrease real GDP per capita at the 61%.

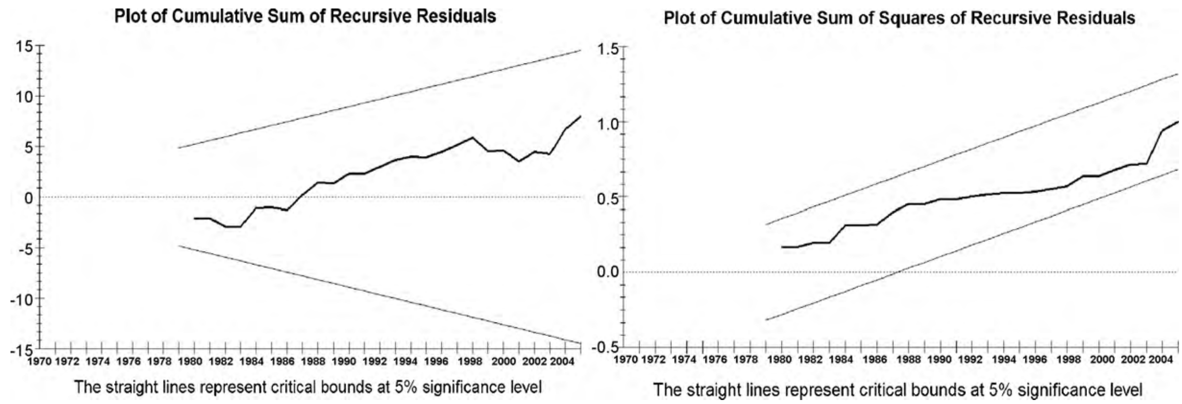


Fig. 2. Plot of Cusum of Squares and Cusum test.

Table 4
Granger causality test results.

	Short-run (or weak) Granger causality				Long-run Granger causality
Variables	Δgap	Δco	Δec	Δem	ψ_i, i = 1, 2, 3, 4
Δgdp	–	2.1269 (0.1447)	0.4819 (0.4876)	9.1876** (0.0024)	4.1862* (0.0408)
Δco	0.3917 (0.5314)	–	0.2729 (0.6014)	0.1368 (0.7115)	0.0020 (0.9652)
Δec	2.1694 (0.1408)	1.2838 (0.2572)	–	0.0050 (0.9438)	0.0644 (0.7997)
Δem	0.6137 (0.4334)	1.6502 (0.1989)	0.5270 (0.4679)	–	1.8621 (0.1724)

Notes: The null hypothesis is that there is no causal relationship between variables. Values in parentheses are *p*-values for Wald tests with a χ^2 distribution. Δ is the first difference operator.
** Indicate 1% significant level.
* Indicate 5% significant level.

The second coefficient implies the income elasticity of energy consumption per capita and an increase in energy consumption per capita will raise real GDP per capita at the 138% (see Table 3).

The estimated *ECT* is also negative (−0.429) and statistically significant at 1% confidence level. *ECT* indicates that any deviation from the long-run equilibrium between variables is corrected about 43% for each period and takes about 2.5 periods to return the long-run equilibrium level. In addition, Fig. 2 presents the plot of cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) test statistics that fall inside the critical bounds of 5% significance. This implies that the estimated parameters are stable over the period of 1968–2005.

This study also explores causal relationship between the variables by using error-correction based Granger causality models which are weak (short-run) Granger causality and long-run Granger causality. The results of both Granger causality models (see Table 4) can be summarized as follows:

(i) Neither carbon emissions per capita nor energy consumption per capita cause real GDP per capita, but employment ratio causes real GDP per capita in the short run.
(ii) We found that there is no causal evidence from the real GDP per capita to carbon emissions per capita in this study. In addition, EKC hypothesis at causal framework by using a linear logarithmic model is not valid in Turkish case.
(iii) There is also no causal evidence from the real GDP per capita to energy consumption per capita or employmet ratio.
(iv) Although the main source of carbon dioxide emissions is the energy consumption, the other most interesting result is that there is no evidence of a causal relationship between carbon emissions and energy consumption.
(v) There is no evidence of a causal relationship between carbon emissions and employment ratio in Turkey.
(vi) Long run causality exists only for the real GDP equation.

The empirical results of our study are mostly consistent with the work of Soytas and Sari [13] but different than the study of Halicioglu [2]. The overall results indicates that energy conservation policies, such as rationing energy consumption and controlling carbon emissions, are likely to have no adverse effect on the real output growth of Turkey.

4. Concluding remarks

This paper examines the long run and causal relationship issues between economic growth, energy consumption, employment ratio and carbon emissions in Turkey by using autoregressive distributed lag (ARDL) bounds testing approach of cointegration and error-correction based Granger causality models for 1968–2005 period.

Empirical results suggest an evidence of a long-run relationship between variables at 5% significance level in Turkey. The estimated income elasticity of carbon emissions per capita is −0.606 and the income elasticity of energy consumption per capita is 1.375. The main results for the existence and direction of Granger causality are as follows:

(i) Neither carbon emissions per capita nor energy consumption per capita cause real GDP per capita, but employment ratio causes real GDP per capita in the short run. Therefore, the government of Turkey can purse conservative energy policy and carbon emissions reduction policy in the long run without impeding economic growth.
(ii) There is no causal evidence from the real GDP per capita to carbon emissions per capita. This also evaluated as no evidence the EKC hypothesis at causal framework by using a linear logarithmic model.
(iii) Although the main source of carbon dioxide emissions is energy consumption, the other most interesting result is that there is no evidence of a causal relationship between carbon

emissions and energy consumption. In addition, there is no evidence of a causal relationship between carbon emissions and employment ratio in Turkey.

(iv) Long run causality exists only for the real GDP equation.

Turkey is a candidate country for full membership to the European Union (EU) and will likely to face significant pressures from EU during negotiations to introduce its national plan on climate change and global warming along with specific emission targets and the associated abatement policies. In the last few years, numerous economic, energy and environmental measures were taken by Turkish government and municipalities to face the abnormal demand on energy and its environmental consequences. However, these measures are not adequate for reducing environmental pollution without any sacrifices on the Turkish economic growth. Therefore, the following additional steps may be proposed for achieving these objectives. These measures are editing the regulations related with reducing the GHG rising form industry, transport and heating, increasing the usage of bio-diesel fuel instead of fossil fuels, improving the alternative energy sources especially like solar and wind energy projects,[1] generalizing the usage of Turkey's important geothermal sources, enhancing public awareness, implementing carbon sequestration technology in power plants and supporting the green investments by applying environmental technologies.

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[1] Turkey has a huge potential of solar energy. The annual average total insolation duration is 2640 h (7.2 h/day) and average annual solar radiation is 1311 kWh/m^2 year (3.6 kWh/m^2 day).